Creating Resiliency in Streams

Restoration and Floodplain Reconnection

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CDM Smith

"…the United States will experience more frequent and more severe flood events in coming years."

From: Addressing Affordability and Long-term Resiliency through the National Flood Insurance Program

"…flood losses continue to increase…

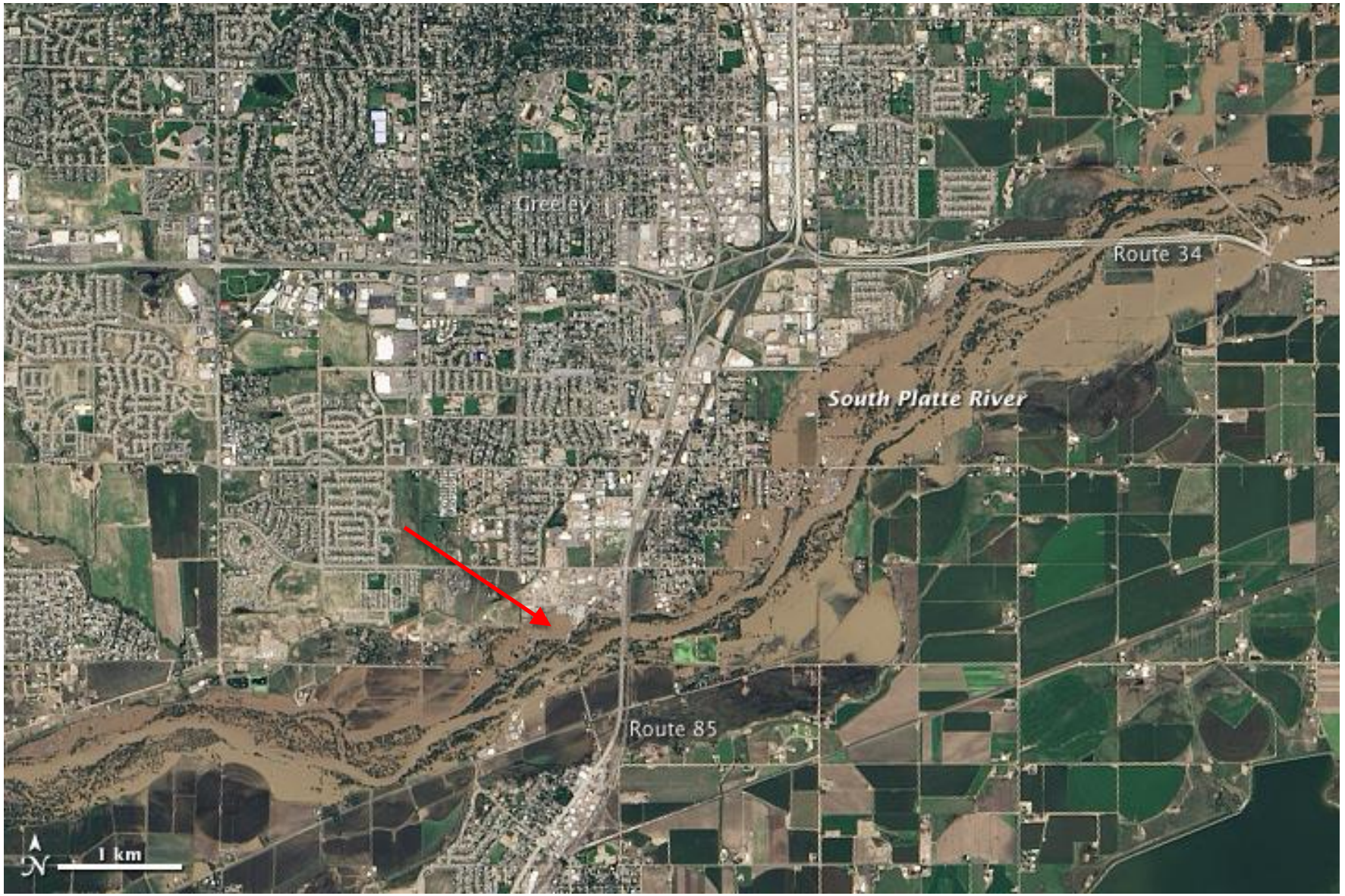
…continued development in and around floodplains…

…effort to curb flood loss has been directed at inundation…

…leaving mitigation to infrastructure…

…on the sidelines."

From: ASFPM Riverine Erosion Hazards White Paper


Greeley
Route 34
South Platte River
Route 85
N
1 km


Our Disaster Recovery Plan
Goes Something Like This...
HELP!
HELP!
DILBERT
By Scott Adams

How do we as floodplain managers, engineers, and scientists manage the nation's long-term flooding risks, while also addressing property buyout and affordability concerns of flood insurance?

Overview

- Risk vs. Uncertainty
- What is resilience and how do we measure it?
- Challenges
- Opportunities
- Take Home Messages

Human created encroachments = risks

Natural variability = uncertainty

What is the Likelihood of Flooding?

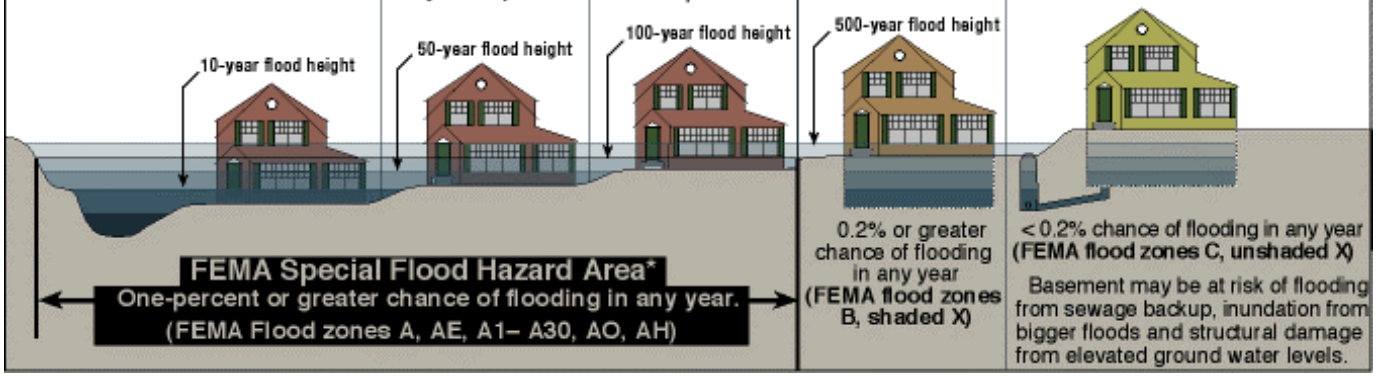
Years in floodplain	Chance of at least one **10-year flood**	Chance of at least one **50-year flood**	Chance of at least one **100-year flood**	Chance of at least one **500-year flood**
1	10%	2%	1%	<1%
2	19%	4%	2%	<1%
3	27%	6%	3%	1%
4	34%	8%	4%	1%
5	41%	10%	5%	1%
10	65%	18%	10%	2%
15	79%	26%	14%	3%
20	88%	33%	18%	4%
25	93%	40%	22%	5%
30	96%	45%	26%**	6%

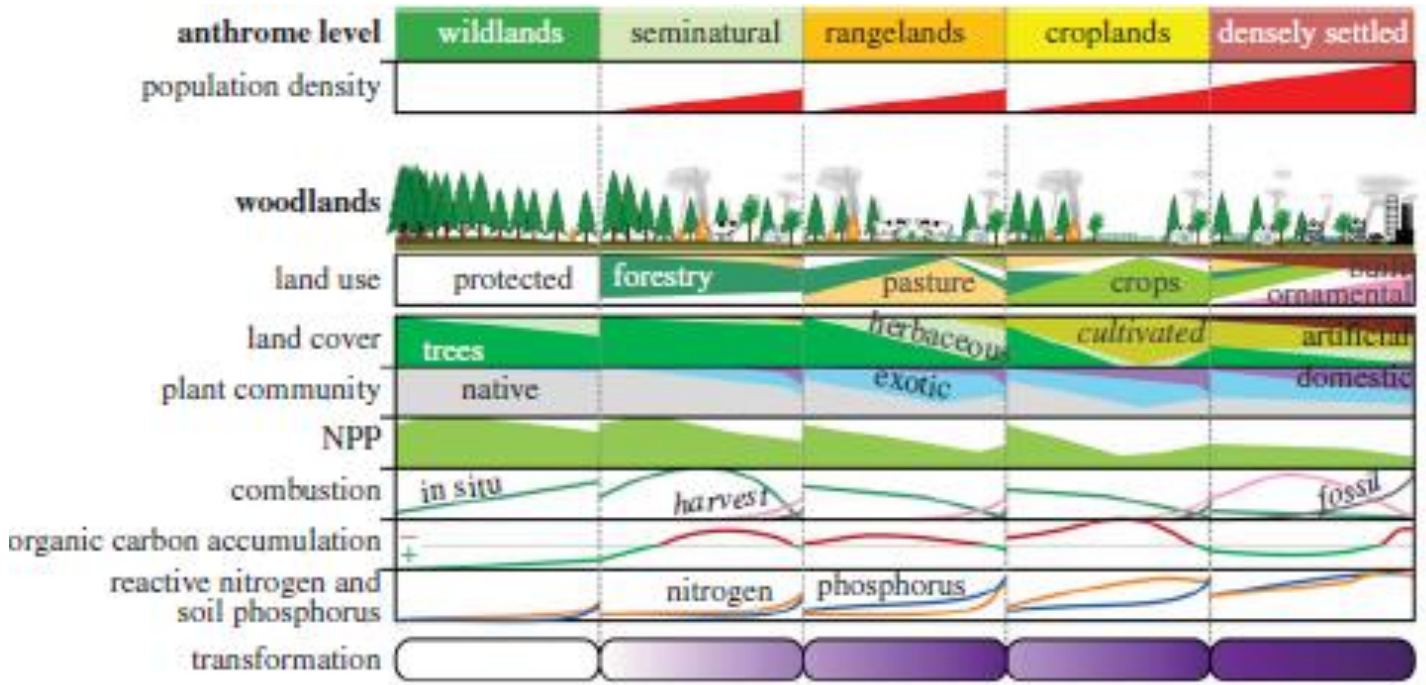
The longer you occupy the floodplain, the greater your chance of being flooded.

FEMA has not identified all areas that may be at risk of flooding. Between 20%–25% of flood insurance claims are from areas OUTSIDE of the FEMA Special Flood Hazard Area in supposedly "low risk" areas.

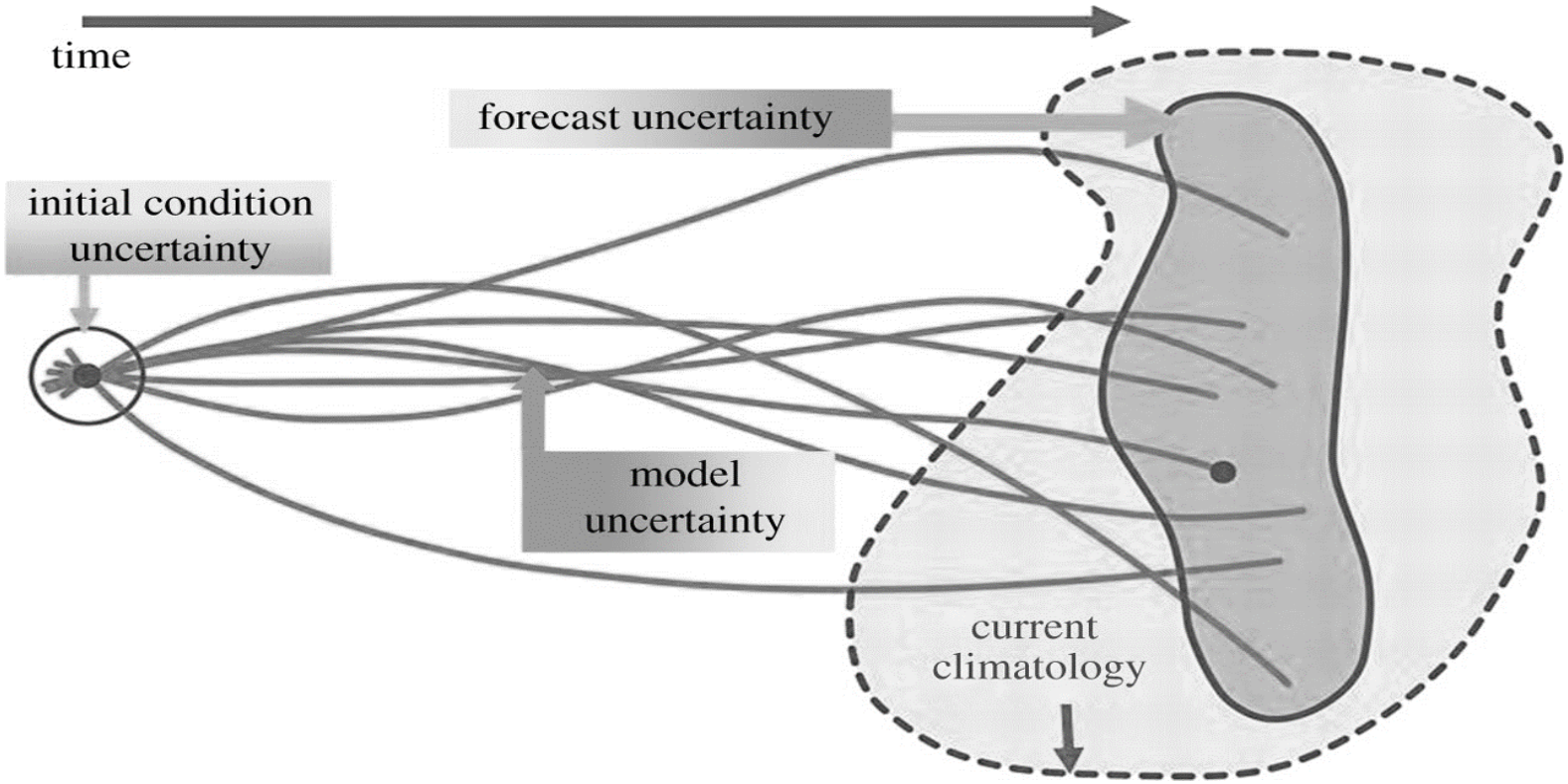
**Over a 30 year mortgage, there is a 26% chance of a 100-year flood.

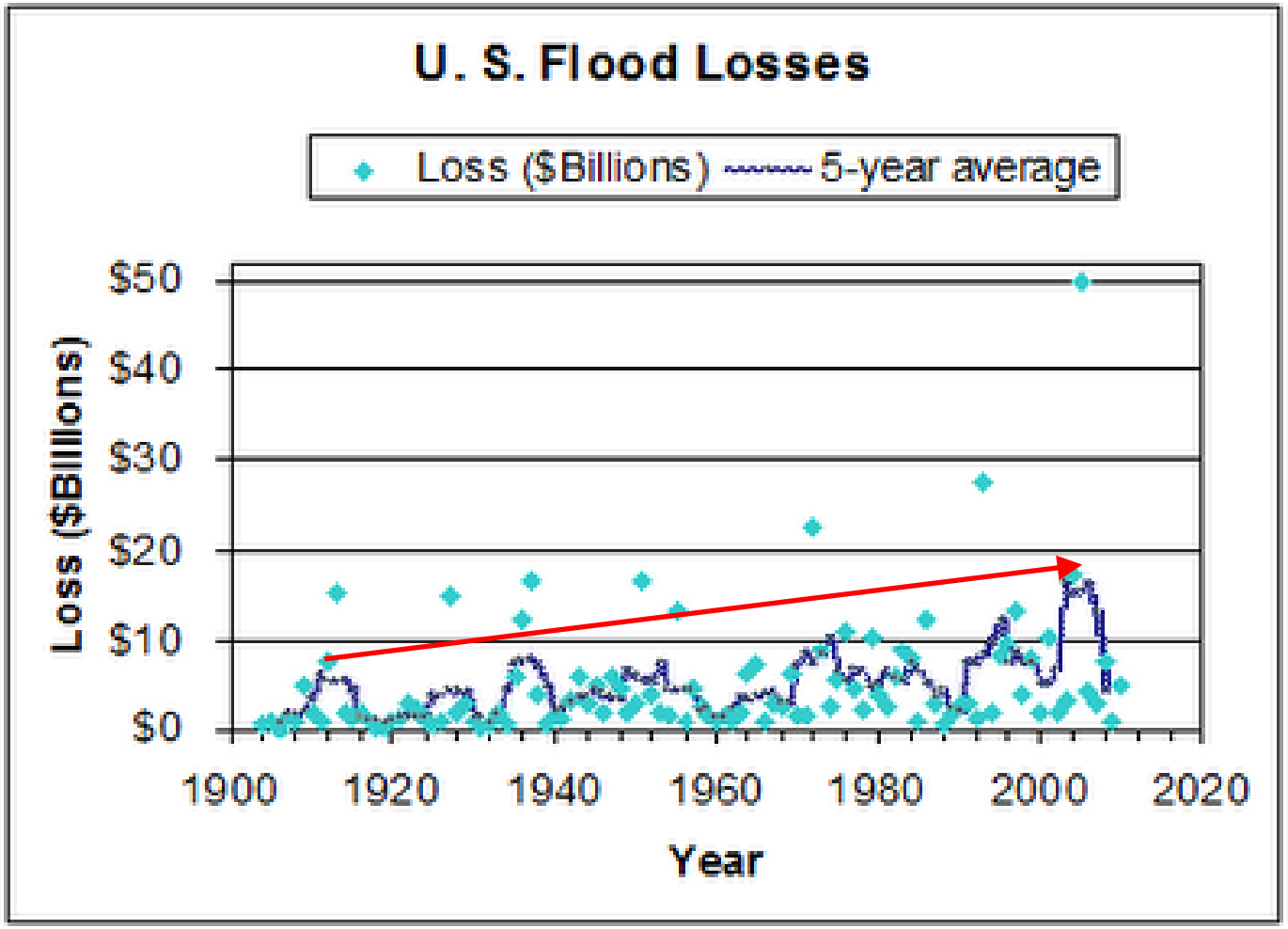
Risk Level:	High Risk	High Risk	High Risk	Medium Risk	Low Risk
	In FEMA 100-year floodplain* Also in: 10, 50 and 500 year floodplain.	In FEMA 100-year floodplain* Also in: 50 and 500 year floodplain.	In FEMA 100-year floodplain* Also in: 500 year floodplain.	In 500-year floodplain	Above 500-year floodplain





From: Anthropogenic Transformations in the Terrestrial Biosphere (Ellis 2011)


time
forecast uncertainty
initial condition uncertainty
model uncertainty
current climatology


U. S. Flood Losses
Loss ($Billions)
5-year average
Loss ($Billions)
$50
$40
$30
$20
$10
$0
1900
1920
1940
1960
1980
2000
2020
Year

Resilience

The power or ability to return to the original form after being stretched.

Toughness.

Resilience

Anticipating/preparing for disturbance.

Improving our capacity to withstand shocks.

Adapting and evolving when possible.

Recovery

Implies downtime and that systems must first suffer an outage before they can resume normal operations

Resiliency

Refers to the ability of a business to spring back from a disruption to its operations without an outage

Resilience

Resiliency

Pivoting from trying to prevent natural disturbances to naturally managing disturbances

Resiliency

"Natural" or "green" infrastructure tends to be more resilient to water stress than human-engineered infrastructure because it bends, rather than breaks.

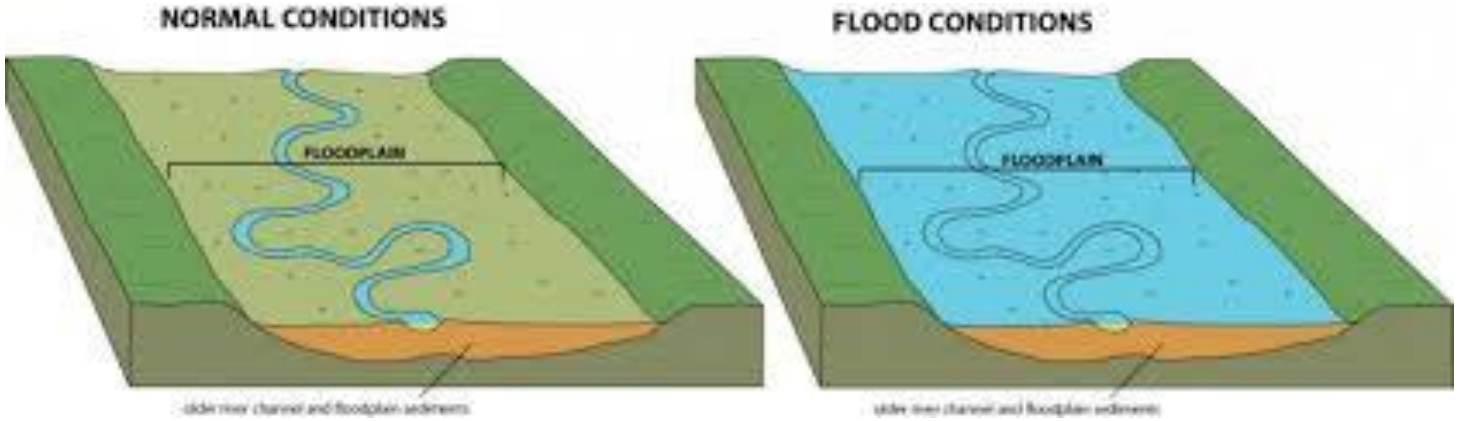
Resiliency

Floodplain reconnection

Trend in (urban) floodplain management and stream restoration

Ability and time to recover

Reduction in impacts


NORMAL CONDITIONS
FLOODPLAIN
FLOOD CONDITIONS
FLOODPLAIN

Resiliency Metrics

Increase magnitude of a flood event that cause significant damages, disruptions, and risks to life safety over what currently exists.

Resiliency Metrics

Percent reduction of land area in the 100-year floodplain

Number of insurable structures left in the floodplain & number of structures removed from the floodplain

Resiliency Metrics

Reduced risk and improved protection to critical water, sanitary sewer, power, and storm drainage infrastructure

Resiliency Metrics

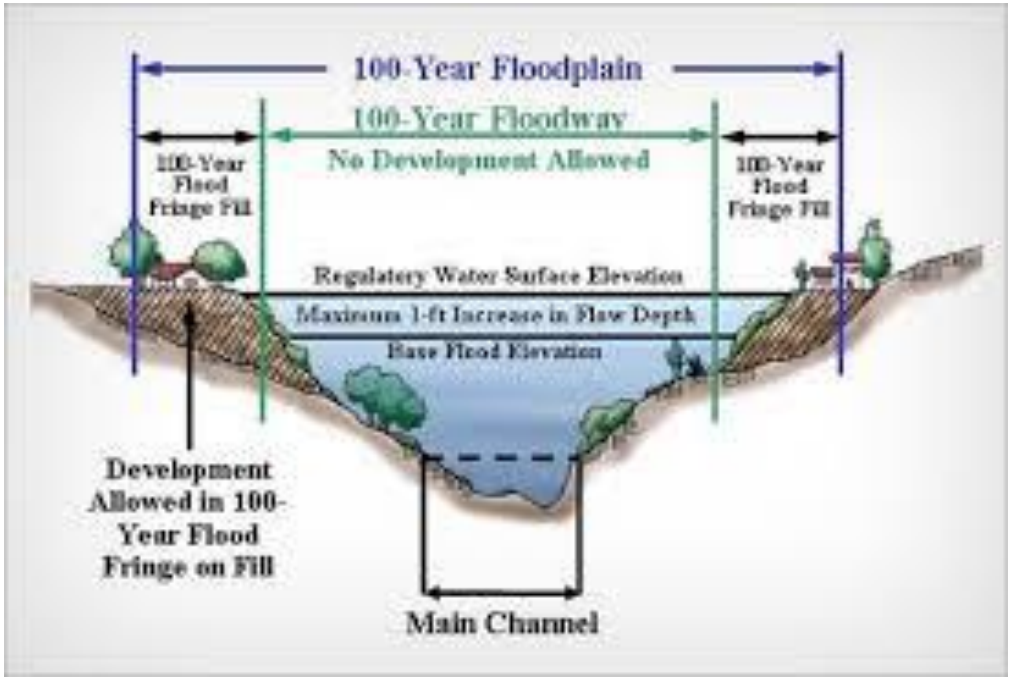
Reconnection of the channel to an active floodplain bench

Increased room for the river channel – will the alternative better allow the river to “be a river”

Challenges

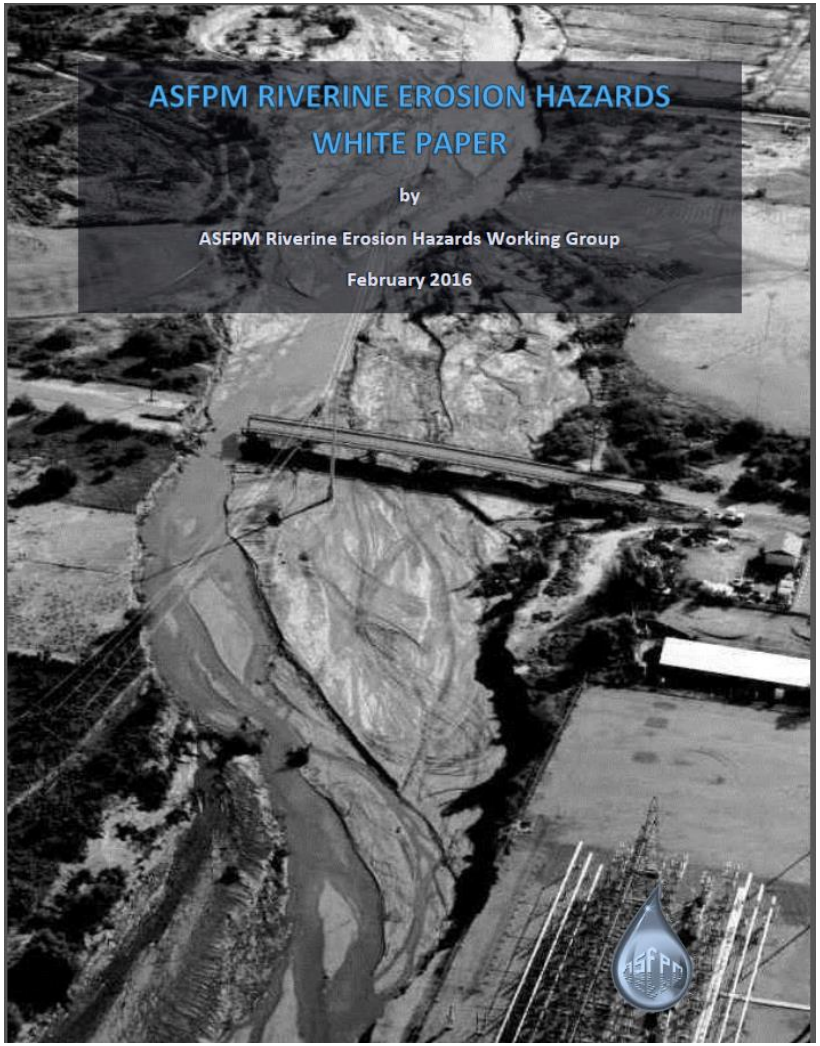
Considering Human Factors such as Private property and Redevelopment

Communicating benefits associated w/ floodplain reconnection


100-Year Floodplain
100-Year Floodway
No Development Allowed
100-Year Flood Fringe Fill
100-Year Flood Fringe Fill
Regulatory Water Surface Elevation
Maximum 1-ft Increase in Flow Depth
Base Flood Elevation
Development Allowed in 100-Year Flood Fringe on Fill
Main Channel

Where I See Opportunities

Where I See Opportunities

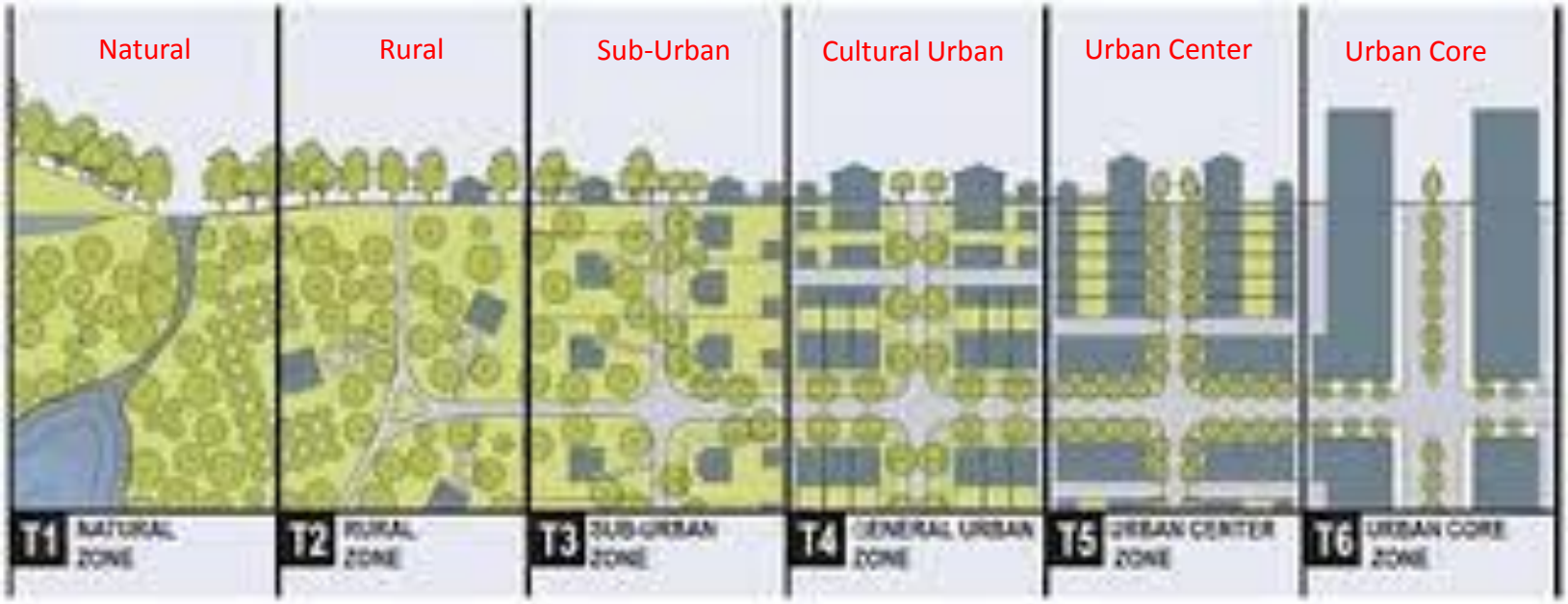


Where I See Opportunities

Manage floods by storing and conveying water on floodplains

Reducing damage to bridges, levees and other infrastructure

Where I See Opportunities

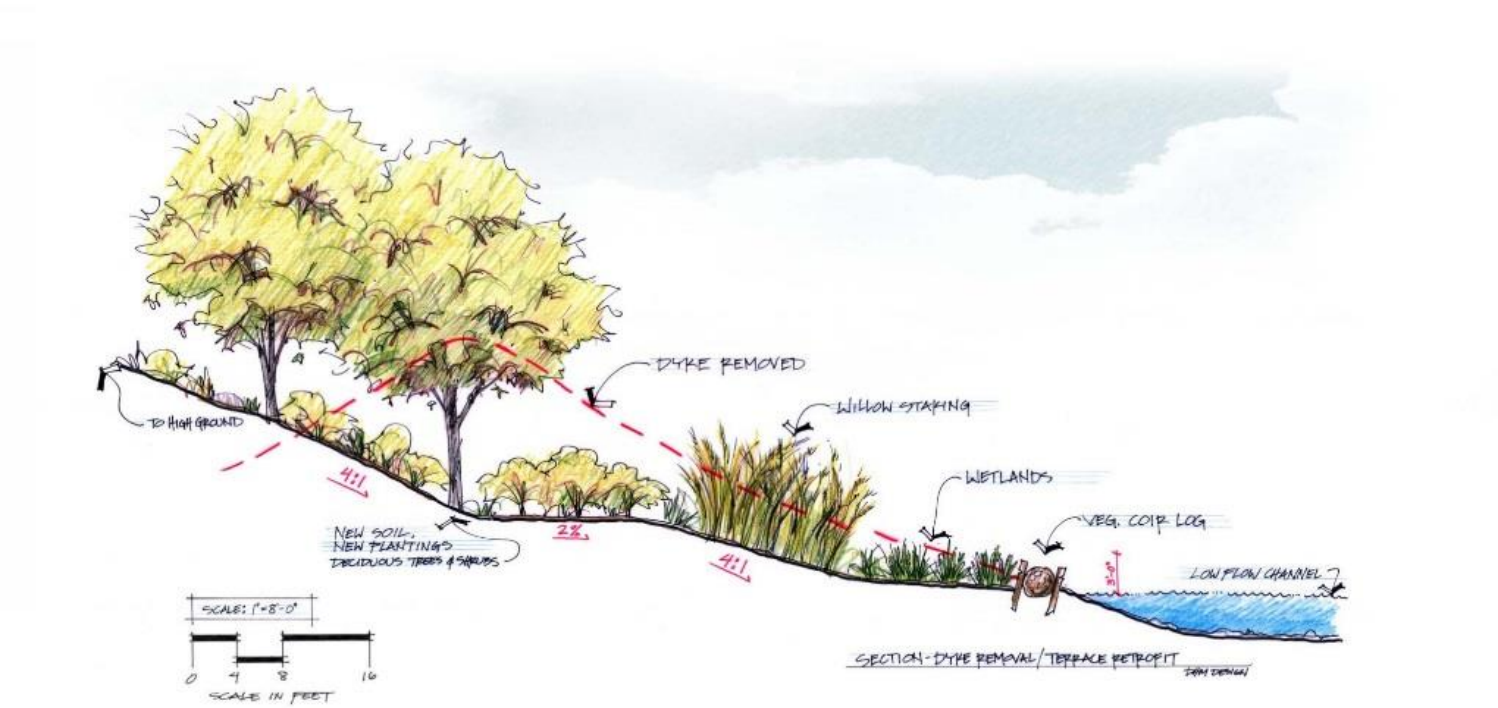


Where I See Opportunities

New flood bypasses or setting back embankments and levees

Riparian Corridor Management - “Activate” floodplain as flood protection

Where I See Opportunities



Where I See Opportunities

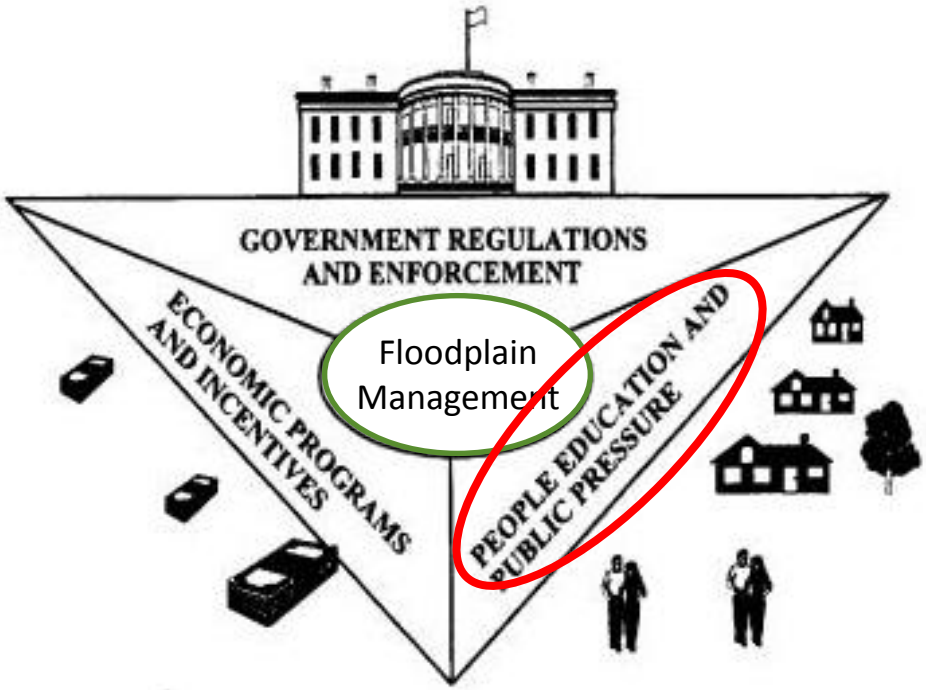


Figure 2.18. Three components of environmental (watershed) management to control pollution. (From Novotny, 2000.)

Where I See Opportunities

Communicating the benefits of floodplain reconnection to the public.

For example, City of Fort Collins, CO

https://youtu.be/Z2uKS0S82q4

Take Home Message

Help the community develop a vision

- What does resiliency look like?
- Status quo vs. what it wants to look like in 5, 10, or 15 years?
- Where will the citizenry want to live, work and raise their children?

Take Home Message

Include natural variability within studies and designs to address risk AND uncertainty

Estimate the mitigation costs and plan for them

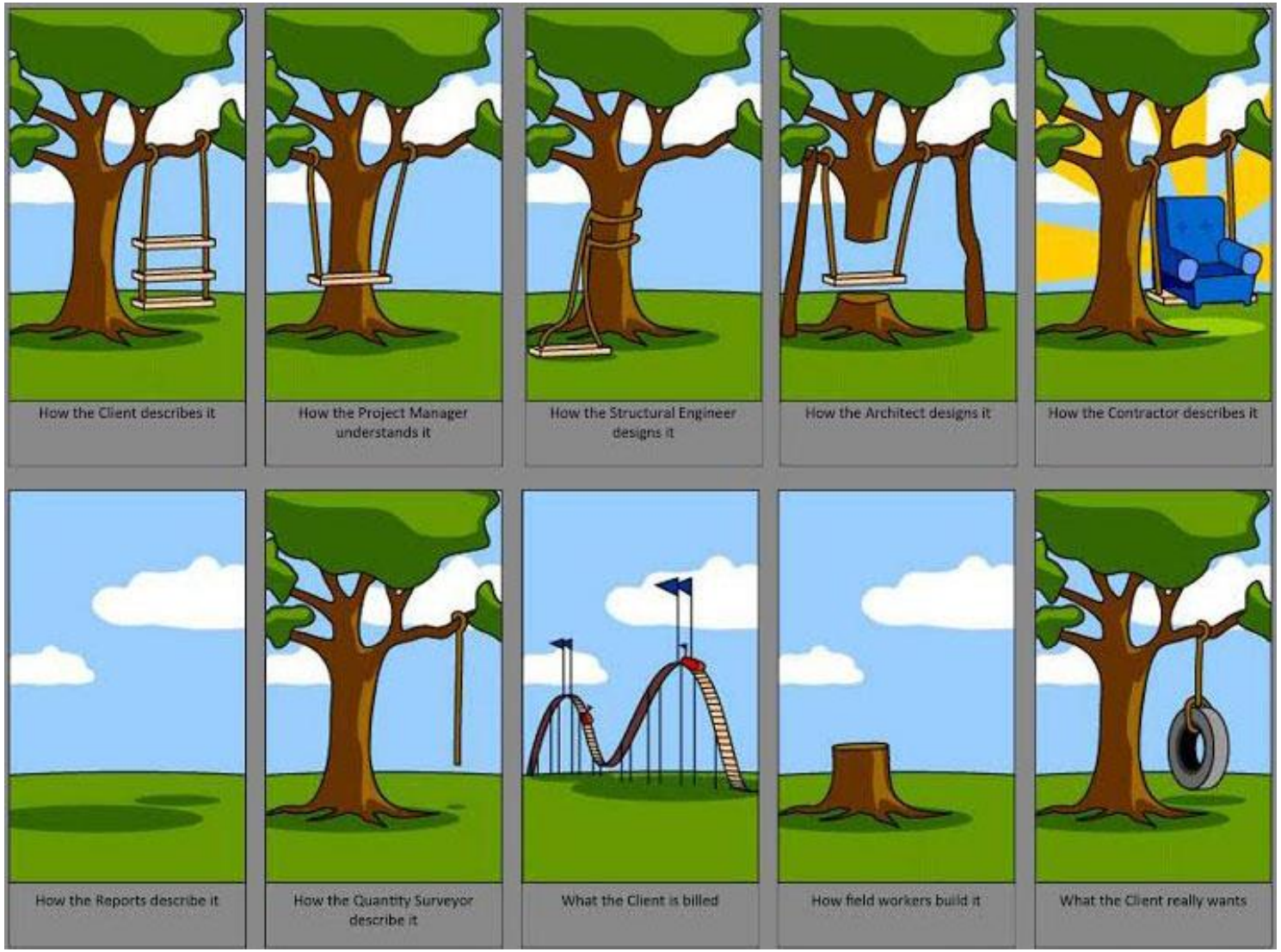
Take Home Message

We should not underestimate or undervalue our role, and the importance of, adaptive change.

Optimize All You Want

"We can't solve problems by using the same kind of thinking we used when we created them."
- Albert Einstein

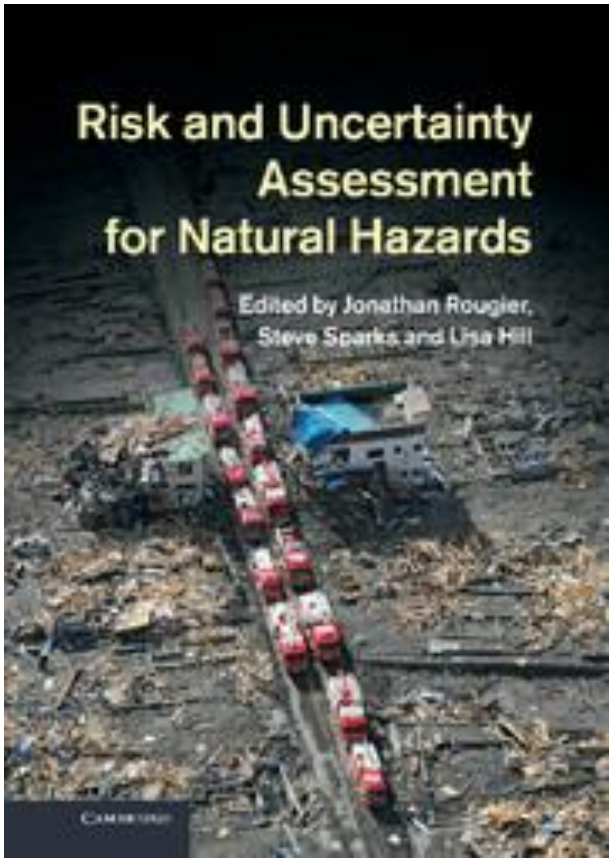
THANK YOU!


How the Client describes it
How the Project Manager understands it
How the Structural Engineer designs it
How the Architect designs it
How the Contractor describes it
How the Reports describe it
How the Quantity Surveyor describe it
What the Client is billed
How field workers build it
What the Client really wants

Resiliency Metrics

1. Percent reduction of land area in the 500-year floodplain
2. Increased hydraulic capacity of the bridge crossing
3. Flow rate that causes overtopping of structure
4. Depth of overtopping of a structure during a 100-year event (the lower the depth, the greater the level of safety)
5. Number and value of properties that should be purchased by community to remove structures from the floodplain (assuming willing sellers)
6. Flow velocity through the bridge (lower velocity means reduced scour and damage potential during flood events)
7. Increased land area available for ecological restoration and improvements
8. Percent increase in available open space/natural land area
9. Opportunity for outdoor/natural areas recreation (i.e., soft path trails, environmental education, access to river, bird watching, fishing, etc.)
10. Benefits to pedestrian and bicycle safety
11. Reduced flooding frequency and damages to the pedestrian trail underpass
12. Number of properties with improved redevelopment potential
13. Ability of the proposed improvements to be resistant and adaptable to future disruptions
14. Reduced maintenance effort and costs
15. Anticipated cost of damages from a flood event

References


Risk and Uncertainty Assessment for Natural Hazards
Edited by Jonathan Rougier, Steve Sparks and Lisa Hill